



Original research

Decreased risk of knee buckling with adductor canal block versus femoral nerve block in total knee arthroplasty: a retrospective cohort study

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ABSTRACT

Background: Femoral nerve (FNB) and adductor canal blocks (ACB) are used in the setting of total knee arthroplasty (TKA), but neither has been demonstrated to be clearly superior. Although dynamometer studies have shown ACBs spare perioperative quadriceps function when compared to FNBs, ACBs have been widely adopted in orthopaedic surgery without significant evidence that they decrease the risk of perioperative falls.

Methods: All patients who received single-shot FNB (129 patients) or ACB (150 patients) at our institution for unilateral primary TKA from April 2014 to September 2015 were retrospectively reviewed for perioperative falls or near-falls during physical therapy and inpatient care.

Results: There were significantly more “near-falls” with documented episodes of knee buckling in the FNB group (17 vs 3, $P = .0004$). These patients’ first buckling episode occurred at an average of 21.1 hours postoperatively (standard deviation 5.83, range 13.83–41.15). There were no significant differences in pain scores between the 2 groups at any of the time periods measured; however, patients in the FNB group consumed significantly fewer opioids on postoperative day 1 than the ACB group (59 morphine equivalents vs 73, $P = .004$).

Conclusions: A significantly higher rate of near-falls with knee buckling during in-hospital physical therapy was discovered in the FNB group. With increasing numbers of TKAs being performed on a “fast-track” discharge model, these results must be seriously considered, particularly in patients planning to go home the same day, to reduce the risk of postoperative falls. These data support the recent clinical data trend favoring ACB over FNB in orthopaedic surgery.

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Introduction

Preoperative peripheral nerve blocks are frequently utilized as part of multimodal pain regimens in total knee arthroplasty (TKA) to provide relief and limit the use of opioid analgesics with their

potential side effects and complications [1,2]. Studies suggest, however, that nerve blocks, specifically a femoral nerve block (FNB), can result in marked quadriceps weakness [3–10]. This muscle weakness can interfere with early ambulation and is thought to lead to an increased risk of falling in the postoperative setting.

Recent literature has discussed the potential of the adductor canal block (ACB) as a safer and equally effective alternative to the FNB. In contrast to the FNB, the ACB is primarily a sensory block and is thought to spare much of the quadriceps muscle due to the more distal injection site. A number of studies have shown that an ACB does in fact preserve quadriceps strength to a greater degree than an FNB [3–10], while providing effective pain relief [4,6–9,11–15].

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In this investigation, we specifically sought to quantify the risk of falling by retrospectively comparing the incidence of recorded falls or “near-falls” during postoperative ambulation in a group of patients who received an ACB for pain relief following unilateral, primary TKA with a separate cohort of patients who received an FNB for the same procedure. For this study, we used knee buckling events as a proxy for measuring the incidence of near-falls. A knee buckle was defined as a sudden and involuntary loss of postural strength and balance as witnessed by our physical therapy (PT) staff, which may or may not have required the patient to brace herself to keep from falling. Our hypothesis was that there would be fewer falls or knee buckles in the ACB group compared to the FNB group. Secondary aims of the study included evaluation of the patient’s pain level, pain medication requirements measured in morphine equivalent levels, and ability to ambulate in the immediate postoperative period.

Material and methods

After receiving Institutional Review Board approval, we queried hospital anesthesia records to retrospectively identify all patients who received either an FNB or an ACB for postoperative pain control between April 2014 and September 2015. From that list, we generated a comparative cohort of all patients who received either a single-shot FNB or ACB for unilateral, primary TKA. The decision to administer FNB vs ACB was made by both the Anesthesia and Orthopaedic provider preference at the time of surgery. Of an initial 515 patients identified as having received FNBs, 386 patients were ultimately excluded for the following reasons: 89 fractures of the hip, femur, patella, tibia, ankle, and foot; 68 anterior cruciate ligament reconstructions, 67 continuous pain catheters, 41 unicondylar knee replacements, 36 hip arthroplasties, 34 bilateral or revision TKAs, 16 quadriceps or patellar tendon repairs, and 18 miscellaneous procedures. The final 17 were excluded due to having inaccessible or incomplete charts or for pre-existing conditions such as chronic opioid use, neuropathies, or nonambulatory status, leaving a total of 129 patients who met inclusion criteria. With respect to the ACB, of an initial list of 434 patients, 284 were ultimately excluded for the following reasons: 70 femur, patella, tibia, ankle, and foot fractures, 62 unicondylar knee replacements, 39 anterior cruciate ligaments, 36 bilateral or revision TKAs, 26 continuous pain catheters, and 26 other procedures. As was the case with the FNB group, the final 25 patients were excluded because of inaccessible or insufficient records as well as for pre-existing conditions, leaving 150 patients who met study criteria.

Patient charts were reviewed to determine demographics data such as patient age, sex, body mass index (BMI), and comorbidities, including the incidence of dementia, cardiovascular disease, neurological and pulmonary disorders, and diabetes. Notes from the first 4 sessions of PT, which were conducted twice daily starting on the morning of postoperative day 1 (POD1) as was protocol during the study period, were evaluated for any recorded falls or objective episodes of knee buckling as witnessed by the therapists. We did not include any instances of subjective buckles reported by patients to avoid inconsistencies in reporting. Nursing and physician records were scanned for notes capturing any falls that did not occur or were not documented during PT. Physical activity was measured by total distance walked (feet) and total stairs ascended at each PT session within the first 2 PODs. Pain scores before and after therapy session were also noted.

Medication dosing charts were consulted for the total consumption of opioids per patient by POD. Multimodal pain regimens included acetaminophen, ketorolac, and gabapentin in addition to opioid medications. Postoperative opioid pain medication was administered by means of a combination of patient-controlled

analgesia (PCA) pumps, nurse-controlled intravenous infusions, and oral tablets. Opioids consumed included hydromorphone, oxycodone, hydrocodone, and morphine sulfate. For ease of analysis, opioid doses were all converted to morphine equivalents using established conversion factors [16].

Operative room records were examined to determine operative time, and discharge notes were reviewed to determine length of stay. All patients in both groups were operated on by one of the 3 attending orthopaedic arthroplasty surgeons at our institution. Surgical approaches were consistent with each surgeon utilizing a midline medial parapatellar approach with eversion of the patella. Additionally, the same team of anesthesiologists performed the blocks using ultrasound guidance for both study groups. All patients in both groups received injections of 0.5% ropivacaine and all blocks were documented as being successful.

The same inpatient PT staff worked with all patients in both study groups and PT protocols had remained constant throughout the data collection period. They consisted of one PT session in the morning and one in the afternoon on POD1 and 2, provided the patients were healthy enough to participate. All patients had been allowed to weight bear as tolerated beginning at the first PT session. Pain ratings on a scale from 0 to 10 which had been collected before the start of each session were recorded. PT sessions generally consisted of a series of mobility and strength exercises both in and out of bed, including gait training that involved walking and climbing stairs as tolerated. All exercises and ambulation were performed under close supervision and contact guard assistance from the therapists as needed. Patients utilized rolling walkers or canes for balance and support. Pain ratings were again collected from the end of each session.

Statistical analysis of all categorical data of event frequencies including comorbidities and knee buckling incidents was performed using Fisher’s exact test (where the event frequency was <5) or chi-square test. Two-sampled, 2-tailed Student’s *t*-tests were conducted to compare all continuous data which included age, BMI, physical activity, and opioids consumed. A *P*-value <.05 was considered to be statistically significant.

Results

Final analysis included 129 FNBs and 150 ACBs for patients treated with unilateral, primary TKA between April 2014 and September 2015. The 2 cohorts were similar with respect to age (FNB = 69.4, ACB = 69.2, *P* = .87), sex (both 21% male), and BMI (FNB = 32.4, ACB = 30.8, *P* = .06) (Table 1). There were no significant differences in the presence of any of the 5 comorbidities measured between the 2 groups, including no differences in the rates of pre-existing neurological disorders (Table 1). The total operative time in both groups was 1 hour 51 minutes (*P* = .87) and there was no statistically significant difference in length of stay between each group (Table 2).

Table 1
Demographic data for ACB and FNB cohorts

Demographics	FNB	ACB	<i>P</i> value
Age, y (range)	69.4 (49–88)	69.2 (47–89)	.87
Male, n (%)	27 (21)	32 (21)	.82
BMI (range)	32.4 (17.3–55.6)	30.8 (18.7–51.9)	.06
Dementia, n (%) ^a	1 (1)	3 (2)	.63
CVD, n (%)	24 (19)	30 (20)	.79
Neurological, n (%) ^a	4 (3)	5 (3)	1
Respiratory, n (%)	18 (14)	16 (11)	.41
DM, n (%)	23 (18)	33 (22)	.45

Values are generated with Fisher’s exact test.

CVD, cardiovascular disease; DM, diabetes mellitus.

^a *P* < .05 is significant.

Table 2
Hospital course

Hospital course	FNB	ACB	P value
Operative time (h:min)	1:51	1:51	.87
Length of stay (d)	3.59	3.43	.27

A review of hospital records revealed a single patient fall in the FNB group and none in the ACB group, which was not statistically significant ($P = .46$) (Table 3). There was, however, a notable and statistically significant difference in episodes of near-fall, that is, knee buckling between the 2 groups; a total of 17 (13%) patients experienced knee buckling events in the FNB group during PT sessions as compared to 3 (2%) total patients in the ACB group ($P = .0004$) (Table 3). Post hoc power analysis using an alpha of 0.05 revealed 94.7% power to detect a difference in the buckling rates between the 2 groups.

Within the ACB group, one patient experienced buckling during the first PT session only, another during the first 2 sessions, and the last during the first 4 sessions. In the FNB group, 4 patients buckled during the first PT session only, 3 buckled during the second session only, 7 experienced buckling during the first 2 sessions, and three buckled during the first 3 sessions. The first episode of knee buckling for these 20 patients occurred at an average of 21.1 hours postoperatively (range 13.83–41.15) and all but one of these patients' buckles occurred within the first 26 hours. There were no significant differences between the 2 groups in time to first knee buckle (Table 3). The earliest buckle occurred at 13.83 hours postoperatively and the latest occurred at 54.52 hours.

No statistically significant differences between patients' subjective pain scores either before or after therapy sessions were discovered (Table 3). There was a statistically significant difference between total opioid consumption in the first POD between the 2 groups. The FNB group consumed 59.8 morphine equivalents v 73.4 morphine equivalents in the ACB group ($P = .005$) (Table 4). There was no significant difference in opioid consumption in any of the

Table 3
Physical therapy data

Physical therapy data	FNB	ACB	P value
Recorded falls	1 (1)	0 (0)	.46
Episodes of knee buckling, <i>n</i> (%)	17 (13)	3 (2)	.0004
First patient session			
Time from surgery (d)	0.87	0.84	.17
Total distance walked (feet)	47.3	35.4	.09
Total stairs climbed	0.22	0.21	.89
Pain VAS: before therapy	3.66	3.3	.34
Pain VAS: after therapy	4.32	3.9	.30
Second patient session			
Time from surgery (d)	1.11	1.13	.64
Total distance walked (feet)	63.3	63.0	.98
Total stairs climbed	0.38	0.34	.82
Pain VAS: before therapy	3.33	3.45	.75
Pain VAS: after therapy	4.00	3.79	.61
Third patient session			
Time from surgery (d)	1.90	1.88	.44
Total distance walked (feet)	94.87	82.8	.32
Total stairs climbed	0.94	0.66	.30
Pain VAS: before therapy	3.54	3.22	.4
Pain VAS: after therapy	4.15	3.6	.15
Fourth patient session			
Time from surgery (d)	2.10	2.22	.01
Total distance walked (feet)	106.0	86.5	.14
Total stairs climbed	1.78	1.04	.06
Pain VAS: before therapy	3.09	2.61	.19
Pain VAS: after therapy	3.63	3.01	.13

Values are generated with Fischer's exact test

Table 4
Narcotics consumption (morphine equivalents)

Narcotics consumption	FNB	ACB	P value
Postop day 0	28.5	24.7	.12
Postop day 1	59.8	73.4	.005
Postop day 2	41.8	45.0	.43
Postop day 3	21.2	20.8	.72
Postop day 4	5.6	5.0	.8
Total consumption	157.5	169.0	.37

other PODs, nor in total opioids consumed (FNB = 157.5, ACB = 169.0, $P = .37$) during patients' hospital stays (Table 4). There were no statistically significant differences in total feet walked or stairs climbed in any of the first 4 PT sessions.

Discussion

Falling after TKA can result in devastating consequences, including periprosthetic fractures or catastrophic soft tissue damage [17,18]. Preventing postoperative falls is therefore of utmost importance to orthopaedic surgeons, anesthesiologists, and the entire care team. There is an ever-increasing focus on improved pain control while maintaining optimal patient safety and reducing length of hospital stay. ACBs for postoperative pain control have been studied as an alternative to more traditional FNBs with the goal of lowering the risk of falling after TKA. In our retrospective study, in which we documented the frequency of falls or knee buckles during postoperative PT sessions, we were able to show that ACBs may potentially be a safer alternative to FNB for postoperative pain control.

Strong evidence exists to support the claim that FNBs impair quadriceps strength postoperatively [3–10]. Moreover, a number of studies have demonstrated that ACBs significantly preserve quadriceps motor function when compared to FNB after TKA, including a number of randomized controlled trials (RCTs) [3–9]. One study demonstrated preserved quadriceps strength and balance with ACB compared to FNB on a cohort of healthy volunteers [10]. A recent RCT, which sought to assess the risk of falling associated with FNB as compared to ACB, demonstrated no significant difference in the 2 groups on either POD1 or POD2 based on the Tinetti Gait and Balance instrument, a tool designed to evaluate and identify elderly patients who are at elevated risk of falling [3]. Close inspection does reveal, however, that in this study 24 of 31 patients in the FNB group were labeled as high risk for falling as compared to 21 of 31 in the ACB group, representing a nonsignificant trend toward an increased risk of falling associated with FNB.

In our study, we retrospectively analyzed 279 patients who had received either FNB or ACB for postoperative pain analgesia after TKA (129 FNB patients and 150 ACB patients) for the incidence of either falls or knee buckles during their PT sessions. Although knee buckles are not falls, they precipitate a sudden loss of balance that could cause many patients, particularly the elderly and weak, to fall. Although we only discovered a single fall in our study, occurring on POD3 to a patient in the FNB group, this was likely due to the fact that these patients were all in a highly monitored, inpatient setting with both a physical therapist and PT aide by the patient's side for each PT session. Despite this close monitoring, there was a statistically significant difference between the number of patients in the FNB group with knee buckles (17 patients, 13%) and the ACB group (3 patients, 2%) ($P = .0004$). We believe this result becomes particularly important when considering that many of these patients would be at home or unmonitored beyond POD2. It is easy to hypothesize that some of these patients who experienced a knee

buckling episode might have suffered falls had they not been ambulating with hospital precautions and close supervision.

Our results also show that the vast majority of these buckles occur within the first 26 hours postoperatively. Only 1 of 20 patients who buckled did so outside of this period suggesting that this may be an important window of concern postoperatively where patients need to be closely monitored to prevent falls. Although we were most concerned about elapsed time before initial buckle, since this approach identified all the patients at risk for falling, a few patients experienced further knee buckles well into POD2 with the longest elapsed time between surgery and knee buckle at just over 54 hours. This suggests that although the initial 26-hour period may be of utmost importance, patients must continue to be supervised well beyond it.

In addition to concerns about safety, our study attempted to assess the efficacy of the FNB and ACB by looking at postoperative pain relief as measured by visual analogue scale (VAS) scores and opioid consumption. Some studies have reported improved pain control with ACB as compared to FNB using VAS scores [10], although the majority of previous series have shown pain control to be similar between the 2 groups [3,5-8,11-14]. The vast majority of studies have shown the difference in opioid consumption between patients who receive FNB and ACB to be insignificant [4,6-9]. In general, our study showed similar pain outcomes, with no difference in VAS at any of the 4 time points measured, total opioids consumed on POD0, POD2, and POD3 and total opioid consumption during postoperative inpatient care. On POD1, however, the ACB group did consume slightly more opioids than the FNB group ($P = .005$). Although this is a statistically significant result, clinically the difference only amounts to a single extra dose of pain medication per 24-hour period (eg, one 10 mg tablet of oxycodone). Moreover, the use of a combination of medication delivery systems, including PCA pumps, oral tablets, and intravenous infusions, and the fact that opioid consumption was similar across the 3 other time points further diminishes the value of this result. Additional prospective analysis is warranted.

Some disagreement exists regarding the effect of the ACB on postoperative mobilization when compared to the FNB. One RCT illustrated that ACB leads to improved ambulation during a 10-m walking test and increased total walking distance; however, this trial compared continuous ACBs with continuous FNBs making it difficult to draw comparisons to our study [4]. Still, a number of other studies have reported similar findings [9,11,14]. Other series, however, including a separate RCT, have shown postoperative ambulation to be equally effective between patients who received ACB and FNB [7,12]. Our study was more specific in addressing different aspects of the PT session, and demonstrated that no significant difference in ambulation distance or stairs climbed exists between patients who received a single-shot ACB or FNB at any point during the first 2 PODs. We acknowledge a significant difference ($P = .01$) between the time from the end of surgery to PT session number 4, when our final measurements of pain and ambulation were recorded. However, given that these PT sessions were more than 2 days following the end of surgery at which time the effects of the nerve blocks should have worn off, and that all but one of the knee buckling events occurred before the fourth PT session, we do not believe that this discrepancy had a significant impact on the results of our investigation.

There are a number of strengths of this study. All surgeries were performed at a single institution within the same 18-month period between April 2014 and September 2015. As a result, all postoperative protocols were similar, including PT follow-up. Additionally, the size of each of the 2 cohorts studied was relatively large compared to other reports in the literature, as previously mentioned. We also believe that our decision to compare only

patients who received a single-shot FNB with those who received a single-shot ACB, and not to include patients who received continuous pain catheters limited potential confounders. By comparing cohorts that were similar with respect to operative time, length of stay, age, BMI, and comorbidities, we were able to effectively reduce variability related to these study parameters.

We also acknowledge the limitations that existed in this study. We were limited by the retrospective nature of our study. We could not control for the involvement of different physical therapists in the care of our patients. Although we believe that the therapists were diligent in recording the events that occurred during the sessions, it is possible that certain knee buckling episodes were missed. By limiting the incidence of knee buckles to objective events recorded by the therapists, we aimed to standardize our definition of a buckle. But, we acknowledge that in so doing we leave open the possibility of missing buckling episodes that occurred outside of PT sessions. We were further limited by the fact that more than one surgeon operated on study patients, although all surgeons used the same midline medial parapatellar approach. Although we were unable to control for the involvement of a variety of anesthesia providers, mild variability in anesthesia provider and technique is common in clinical practice. However, an ideal study would have been prospective in nature with a clearly delineated anesthetic protocol. We were also unable to control for different postoperative opioid delivery methods, which ranged from oral tablets to PCA pumps.

TKA is constantly evolving. Due to advances in perioperative pain control and minimally invasive surgical techniques, fast-track and outpatient TKAs are being performed more frequently [19-22]. This trend will likely continue to rise in the coming years with the advent of bundled payments and the emphasis on cost-effective healthcare solutions. In this environment, the safety and efficacy of peripheral nerve blocks is subject to even higher scrutiny. Our study illustrated how the use of an ACB in the place of an FNB may minimize the risk associated with falling after TKA while providing effective pain relief and allowing for postoperative ambulation. To our knowledge, this is the largest study to evaluate both pain relief in conjunction with fall risk, quality, and safety of nerve blockade in this older patient population. Though previous studies have compared the 2 groups with respect to pain, few studies have parlayed pain control and fall risk into a single investigation. This risk becomes increasingly relevant in the context of outpatient or fast-track TKA procedures, where patients will be monitored for a shorter period postoperatively. We also identified a 26-hour window postoperatively where patients may be at highest risk for falling. Further prospective, RCTs are warranted. In the meantime, surgeons and anesthesiologists should consider using ACBs in place of FNBs in the future, particularly as one component of a multimodal analgesic technique for fast-track and outpatient TKA.

Conclusions

A significantly higher rate of near-falls with knee buckling during in-hospital PT was discovered in the FNB group. With increasing numbers of TKAs being performed on a “fast-track” discharge model, these results must be seriously considered, particularly in patients planning to go home the same day, to reduce the risk of postoperative falls. These data support the recent clinical data trend favoring ACB over FNB in orthopaedic surgery.

References

- [1] Allen HW, Liu SS, Ware PD, Nairn CS, Owens BD. Peripheral nerve blocks improve analgesia after total knee replacement surgery. *Anesth Analg* 1998;87(1):93.

- [2] Jenstrup MT, Jæger P, Lund J, et al. Effects of adductor-canal-blockade on pain and ambulation after total knee arthroplasty: a randomized study. *Acta Anaesthesiol Scand* 2012;56(3):357.
- [3] Elkassabany NM, Antosh S, Ahmed M, et al. The risk of falls after total knee arthroplasty with the use of a femoral nerve block versus an adductor canal block: a double-blinded randomized controlled study. *Anesth Analg* 2016;122(5):1696.
- [4] Shah NA, Jain NP. Is continuous adductor canal block better than continuous femoral nerve block after total knee arthroplasty? Effect on ambulation ability, early functional recovery and pain control: a randomized controlled trial. *J Arthroplasty* 2014;29(11):2224.
- [5] Grevstad U, Mathiesen O, Valentiner LS, et al. Effect of adductor canal block versus femoral nerve block on quadriceps strength, mobilization, and pain after total knee arthroplasty: a randomized, blinded study. *Reg Anesth Pain Med* 2015;40(1):3.
- [6] Kim DH, Lin Y, Goytizolo EA, et al. Adductor canal block versus femoral nerve block for total knee arthroplasty: a prospective, randomized, controlled trial. *Anesthesiology* 2014;120(3):540.
- [7] Jæger P, Zaric D, Fomsgaard JS, et al. Adductor canal block versus femoral nerve block for analgesia after total knee arthroplasty: a randomized, double-blind study. *Reg Anesth Pain Med* 2013;38(6):526.
- [8] Li D, Ma GG. Analgesic efficacy and quadriceps strength of adductor canal block versus femoral nerve block following total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc* 2016;24(8):2614.
- [9] Zhao XQ, Jiang N, Yuan FF, Wang L, Yu B. The comparison of adductor canal block with femoral nerve block following total knee arthroplasty: a systematic review with meta-analysis. *J Anesth* 2016;30:745.
- [10] Kwofie MK, Shastri UD, Gadsden JC, et al. The effects of ultrasound-guided adductor canal block versus femoral nerve block on quadriceps strength and fall risk: a blinded, randomized trial of volunteers. *Reg Anesth Pain Med* 2013;38(4):321.
- [11] Kuang MJ, Xu LY, Ma JX, et al. Adductor canal block versus continuous femoral nerve block in primary total knee arthroplasty: a meta-analysis. *Int J Surg* 2016;31:17.
- [12] Dong CC, Dong SL, He FC. Comparison of adductor canal block and femoral nerve block for postoperative pain in total knee arthroplasty: a systematic review and meta-analysis. *Medicine (Baltimore)* 2016;95(12):e2983.
- [13] Ludwigson JL, Tillmans SD, Galgon RE, et al. A comparison of single-shot adductor canal block vs femoral nerve catheter for total knee arthroplasty. *J Arthroplasty* 2016;31(3):741.
- [14] Patterson ME, Bland KS, Thomas LC, et al. The adductor canal block provides effective analgesia similar to a femoral nerve block in patients undergoing total knee arthroplasty—a retrospective study. *J Clin Anesth* 2015;27(1):39.
- [15] Memtsoudis SG, Yoo D, Stundner O, et al. Subartorial adductor canal vs femoral nerve block for analgesia after total knee replacement. *Int Orthop* 2015;39(4):673.
- [16] Cupp M. Pharmacist's Letter/Prescriber's Letter. Therapeutic Research Center; August 2012. p. 1.
- [17] Church S, Robinson TN, Angles EM, Tran ZV, Wallace JI. Postoperative falls in the acute hospital setting: characteristics, risk factors, and outcomes in males. *Am J Surg* 2011;201:197.
- [18] Nadkarni JB, Iyengar KP, Dussa C, Watwe S, Vishwanath K. Orthopaedic injuries following falls by hospital in-patients. *Gerontology* 2005;51:329.
- [19] Berger RA, Cross MB, Sanders S. Outpatient hip and knee replacement: the experience from the first 15 years. *Instr Course Lect* 2016;65:547.
- [20] Parcels BW, Giacobbe D, Macknet D, et al. Total joint arthroplasty in a stand-alone ambulatory surgical center: short-term outcomes. *Orthopedics* 2016;39:223.
- [21] Lombardi Jr AV, Barrington JW, Berend KR, et al. Outpatient arthroplasty is here now. *Instr Course Lect* 2016;65:531.
- [22] Specht K, Kjaersgaard-Andersen P, Pedersen BD. Patient experience in fast-track hip and knee arthroplasty—a qualitative study. *J Clin Nurs* 2016;25(5-6):836.